

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY


(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 15 NOV 2005

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Applicant's or agent's file reference 1040805 PCT		FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/IB2004/002465	International filing date (day/month/year) 02.08.2004 ✓	Priority date (day/month/year) 31.07.2003 ✓	
International Patent Classification (IPC) or national classification and IPC B62D5/04, B62D7/02			
Applicant GAETANI, Angelo ✓			
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet. ✓</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau a total of 11 sheets, as follows: ✓</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>			
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>			
Date of submission of the demand 26.05.2005 ✓		Date of completion of this report 16.11.2005	
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized Officer Tiedemann, D Telephone No. +31 70 340-1931	



**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
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Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

Description, Pages

2, 6, 9	as originally filed
1, 1bis, 3-5, 7, 8	received on 09.06.2005 with letter of 09.06.2005

Claims, Numbers

1-27	received on 09.06.2005 with letter of 09.06.2005
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Drawings, Sheets

1/6-6/6	as originally filed
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- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
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Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-27
	No: Claims	
Inventive step (IS)	Yes: Claims	1-27
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-27
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V.

- 1 The following documents are referred to in this communication:
D1 : EP 0 716 974 A (FUJI ELECTRIC CO LTD) 19 June 1996 (1996-06-19)
D2 : DE 91 03 467 U (WEBER GETRIEBE GMBH MÜNSTER) 29 May 1991
(1991-05-29)
D3 : US 3 587 767 A (GAMAUNT ROGER L) 28 June 1971 (1971-06-28)
D4 : EP 0 741 069 A (BARUZZI ADRIANO ; BUCCHI MAURO (IT); GAETANI
ANGELO (IT); BALDINI DOME) 6 November 1996 (1996-11-06)

2 INDEPENDENT CLAIM 1

2.1 The present application meets the criteria of Article 33(1) PCT, because the subject-matter of claim 1 corresponds to the requirements of novelty in the sense of Article 33(2) PCT.

Document D1 - EP 0 716 974 A (FUJI ELECTRIC CO LTD) 19 June 1996 (1996-06-19) - is considered to be the closest prior art and discloses (the references in parenthesis applying to this document):

Steering apparatus for steering wheels (Fig.5,pos.1) of a vehicle, comprising support means (Fig.5,pos.3) arranged for supporting said wheels (Fig.5,pos.1) driving means (Fig.2,5,pos.12) arranged for rotating said support means (Fig.5,pos.3) around respective longitudinal axis means (Fig.2, Axis through pos.13) and connecting means arranged for connecting said driving means (Fig.2,5,pos.12) with said support means (Fig.2,5,pos.3),said connecting means comprises transmission gear means (Fig.2,pos.11,9) which comprises gear wheel means associated with said support means and further gear wheel means connected with said driving means and engaging with said gear wheel means,
characterised in that
said further gear wheel means has a pitch diameter - smaller - than the pitch diameter of said gear wheel means. (see Fig.2)

(The independent claim 11 is of the same category like independent claim 1 and shows

either a plurality of inter-related products and a different use for the device claimed being a vehicle with the features of the steering apparatus in claim 1.)

3 OBJECTIVE PROBLEM

3.1 The device according to D1 when being operated will only allow a slow delayed transmission of steering signals to the wheels. Wherever a fast correction is necessary the operator will encounter handling difficulties to keep the vehicle on the intended target line or risk to overcharge the driving motor easily by steady path correction. This results either in a uncomfortable feeling of the operator and in difficulties with controlling and balancing the vehicle.

4 SOLUTION

4.1 The solution can be found in the features of claim 1, wherein the further gear wheel means has a pitch diameter - larger - than the pitch diameter of said gear wheel means. Thus the ratio is changed and transmission properties to be used for quick remote direction changes is improved.

This solution is neither anticipated nor combinable from the teachings of the documents found in the prior art.

An expert skilled in that field who was facing that problem would rather go for an advanced remote control system than for the suggested mechanical solution.

CLAIMS

1. Steering apparatus for steering wheels (1) of a vehicle (2), comprising support means (4) arranged for supporting said wheels (1), driving means (27) arranged for rotating said support means (4) around respective longitudinal axis means (2) and connecting means arranged for connecting said driving means (27) with said support means (4), said connecting means comprising transmission gear means (26) which comprises gear wheel means (10) associated with said support means (4) and further gear wheel means (15) connected with said driving means (27) and engaging with said gear wheel means (10), characterised in that said further gear wheel means (15) has a pitch diameter greater than the pitch diameter of said gear wheel means (10).
2. Apparatus according to claim 1, wherein said gear wheel means (10) and said further gear wheel means (15) have respective axes of rotation mutually parallel.
3. Apparatus according to claim 1, wherein said gear wheel means (10) and said further gear wheel means (15) have respective axes of rotation mutually concurrent.
4. Apparatus according to claim 1, wherein said gear wheel means (10) and said further gear wheel means (15) have respective axes of rotation mutually non-intersecting.
5. Apparatus according to any preceding claim, wherein said further gear wheel means comprises a sector gear (15).
6. Apparatus according to any preceding claim, wherein said driving means (27) comprises electric motor means (13).
7. Apparatus according to any one of claims 1 to 5, wherein said driving means (27) comprises hydraulic motor means.
8. Apparatus according to any one of claims 1 to 5, wherein said driving means comprises actuator means (18; 21; 28).
9. Apparatus according to claim 8, wherein said connecting means further comprises link means arranged for connecting

- said actuator means (18; 21; 28) with said further gear wheel means (15).
10. Apparatus according to claim 9, wherein said link means comprises lever means (16) pivotally connected with said further gear wheel means (15) in eccentric position.
 11. Vehicle, comprising steering wheel means (1) and steering means (3) arranged for controlling said steering wheel means (1), said steering means (3) comprising support means (4) arranged for supporting said steering wheel means (1), driving means (27) arranged for rotating said support means (4) around respective longitudinal axis means (2) and connecting means arranged for connecting said driving means (27) with said support means (4), said connecting means comprising transmission gear means (26) which comprises gear wheel means (10) associated with said support means (4), and further gear wheel means (15) connected with said driving means (27) and engaging with said gear wheel means (10), characterised in that said further gear wheel means (15) has a pitch diameter greater than the pitch diameter of said gear wheel means (10).
 12. Vehicle according to claim 11, wherein said gear wheel means (10) and said further gear wheel means (15) have respective axes of rotation mutually parallel.
 13. Vehicle according to claim 11, wherein said gear wheel means (10) and said further gear wheel means (15) have respective axes of rotation mutually concurrent.
 14. Vehicle according to claim 11, wherein said gear wheel means (10) and said further gear wheel means (15) have respective axes of rotation non-intersecting.
 15. Vehicle according to any one of claims 11 to 14, wherein said further gear wheel means comprises a sector gear (15).

16. Vehicle according to any one of claims 11 to 15, wherein said steering wheel means (1) comprises a first steering wheel (1') and a second steering wheel (1'').
17. Vehicle according to any one of claims 11 to 16, wherein said driving means (27) comprises motor means (13).
18. Vehicle according to claim 17, wherein said motor means comprises electric motor means (13).
19. Vehicle according to claim 17, wherein said motor means comprises hydraulic motor means.
20. Vehicle according to any of claims 17 to 19 as claim 17 is appended to claim 16, wherein said motor means (13) comprises a first motor (13) associated with said first steering wheel (1') and a second motor (13) associated with said second steering wheel (1'').
21. Vehicle according to claim 20, and further comprising electronic command and control means arranged for actuating said first motor (13) and said second motor (13) so as to coordinate the relative rotation of said first steering wheel (1') and said second steering wheel (1'').
22. Vehicle according to any one of claims 11 to 16, wherein said driving means comprises actuator means (18; 21; 28).
23. Vehicle according to claim 22, wherein said connecting means further comprises link means arranged for connecting said actuator means (18; 21; 28) with said further gear wheel means (15).
24. Vehicle according to claim 23, wherein said link means comprises lever means (16) pivotally connected with said further gear wheel means (15) in eccentric position.
25. Vehicle according to any of claims 22 to 24 as claim 22 is appended to claim 16, wherein said actuator means comprises a first actuator (18) associated with said first steering wheel (1') and a second actuator (18) associated with said second steering wheel (1'').

26. Vehicle according to claim 25, and further comprising electronic command and control means arranged for actuating said first actuator (18) and said second actuator (18) so as to coordinate the relative rotation of said first steering wheel (1') and said second steering wheel (1'').
27. Vehicle according to claim 23, or 24, as claim 22 is appended to claim 16, wherein said actuator means comprises an actuator (21; 28) suitable for simultaneously controlling, via said link means, said first steering wheel (1') and said second steering wheel (1'').

STEERING DEVICE FOR STEERING WHEELS

The present invention relates to a steering apparatus for a vehicle, particularly a vehicle for the inside transport, such as a lift truck.

EP 0716974 discloses a driving unit for an omnidirectional vehicle. According to EP 0716974, a driving wheel that also serves as a steering wheel is rotatably supported, through a wheel shaft on that the driving wheel is mounted, by a suspension that serves as a steering shaft. The upper end of the suspension is supported rotatably around the vertical axis through a shaft bush to the body of the vehicle. A gear is installed coaxially on the upper face of the suspension and coupled with a further gear supported on the body. The further gear is coupled to an output shaft of a motor that serves as an actuator.

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1 bis

STEERING DEVICE FOR STEERING WHEELS

~~The present invention relates to a steering apparatus for a vehicle, particularly a vehicle for the inside transport, such as a lift truck.~~

In EP 0741069 four wheels provided lift trucks are disclosed comprising a pair of front driving wheels and a pair of rear steering wheels, such rear steering wheels being each supported by a respective supporting element.

Such lift trucks further comprise a steering apparatus, associated with said rear steering wheels, which comprises a mechanism, for example a system of articulated bars, provided with end bars, each of which is adapted so as to force one of said support elements to perform an oscillation of predetermined amplitude around a substantially vertical axis.

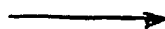
The system of bars, for example driven by a hydraulic cylinder, controls the rotation of the support elements of the rear steering wheels, enabling these latter to rotate around one or the other direction.

A disadvantage of the known apparatuses is that said mechanism can reach a dead centre configuration in which a further stress imposed on the bars by the hydraulic cylinder can also not produce a respective rotation of the support elements of the wheels in the desired direction, which can also results in blocking the mechanism itself.

Consequently, the mechanism can damage itself and can further damage parts of the vehicle against which the bars, forming the mechanism itself, impact following an anomalous rotation.

In order to prevent the previous described disadvantage, the mechanism is driven so that, in operation, it does not reach said dead centre.

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pinion means associated with the supporting means of the wheels.

In particular, by properly dimensioning the ring gear means and the pinion means, a rotation of limited amplitude of the ring gear means implies a rotation of remarkable amplitude of the pinion means and, consequently, of the wheels connected thereto.

In that case, when the ring gear means are actuated by lever mechanisms, these latter can be driven so as to operate by maintaining themselves in safety conditions, i.e. without reaching a dead centre of operation.

In a second aspect of the invention, a vehicle is provided comprising ~~steered~~^{STEERING} wheel means and steering means arranged for controlling said ~~steered~~^{STEERING} wheel means, said steering means comprising support means arranged for supporting said ~~steered~~^{STEERING} wheel means, driving means arranged for driving said support means to be rotated around respective longitudinal axis means and connecting means arranged for connecting said driving means with said support means, characterised in that, said connecting means comprises transmission gear means.

Owing to this aspect of the invention, a vehicle can be obtained provided with a limited turning radius.

In a version, the ~~steered~~^{STEERING} wheel means comprises a pair of ~~steered~~^{STEERING} wheels, each of which driven by respective driving means.

Thus, a vehicle can be obtained provided with independent ~~steered~~^{STEERING} wheels.

The invention will be better understood and carried out with reference to the enclosed drawings, that illustrate some exemplifying and not restrictive embodiments thereof, wherein:

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Figure 1 is a front view of ^{STEERING} ~~(steered)~~ wheels of a vehicle with which a steering apparatus according to the invention is associated;

Figure 2 is a schematic side view of a wheel with which a steering apparatus according to the invention is associated;

Figure 3 is a schematic plan view of the steering apparatus of Figure 1;

Figure 4 is a view like Figure 3 in which the ^{STEERING} ~~(steered)~~ wheels are arranged in a configuration where the vehicle shows the minimal turning radius;

Figures 5A to 5E are schematic plan views of a four-wheel vehicle with the rear wheels of which a steering apparatus according to the invention is associated, with ^{STEERING} ~~(steered)~~ wheels in a position progressively varying between the position in which the wheels are not steered and the position of minimal turning radius;

Figure 6 is a plan view of a version of the steering apparatus associated with a pair of ^{STEERING} ~~(steered)~~ wheels of a vehicle;

Figure 7 is a plan view of a further version of the steering apparatus associated with a pair of ^{STEERING} ~~(steered)~~ wheels of a vehicle;

Figure 8 is a plan view of a still further version of the steering apparatus associated with a pair of ^{STEERING} ~~(steered)~~ wheels of a vehicle.

With reference to Figures 1, 2, 3 and 4, a lift truck 2 is shown provided with ^{STEERING} ~~(steered)~~ wheels 1 with which a steering apparatus 3 according to the invention is associated.

Each wheel 1 is connected with a stem 4 having substantially vertical longitudinal axis Z.

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Each stem 4 can be driven to rotate around the Z axis in both directions in order to enable steering of the wheel 1 connected thereto.

Stem 4 is supported by angular contact bearings 6 mounted within a support 5 that can be translated in the direction of the axis Z within a sleeve 7 rigidly connected with the frame 8 of the lift truck 2.

The stem 4, the support 5 and the sleeve 7 define, as a whole, a double-acting hydraulic cylinder suitable for receiving pressurised oil. As disclosed in EP 0741069, the cylinder associated with one ~~steered~~^{STEERING} wheel is hydraulically connected, via conduits not shown, with the cylinder associated with the other ~~steered~~^{STEERING} wheel.

Consequently, the pressurised oil exiting one hydraulic cylinder is forced to enter the other hydraulic cylinder.

This enables to prevent instability problems of the lift truck 2 caused by possible terrain unevenness whereon wheels 1 are moving.

In particular, the movement of each of the supports 5 within the respective sleeve 7, enables the frame 8 to be maintained roughly at a same height from the terrain also in the presence of depressions.

At an end 29 of the stem 4 a wheel hub 9 is connected that may be either of the type for a single wheel or for twin wheels, wherein two wheels are mounted on the same hub as shown in Figure 1.

The steering apparatus 3 comprises transmission gear means 26 associated with each stem 4 and configured so as to drive turning of said wheel.

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In a version not shown, the steering apparatus 3 may be associated with the ~~steered~~^{STEERING} wheel, for example the rear wheel, of a three-wheel vehicle.

In the Figures 4 and 5E, the configuration of maximal steering of the lift truck is shown, i.e. the configuration of minimum turning radius.

The lift truck 2 is provided with two front driving wheels 14' and 14'', mounted on a transversal front axis A of the lift truck 2, and two rear ~~steered~~^{STEERING} wheels 1' and 1''.

Maximal steering of the lift truck 2 is obtained when the centre of rotation of the lift truck 2 lies on the longitudinal middle plane B of the lift truck 2 itself, at the intersection point between the middle plane B of the truck and the front transversal axis A.

Figures 5A to 5E show the positions that can be taken by the rear ~~steered~~^{STEERING} wheels 1' and 1'' in order to meet the configuration of maximal steering, by starting from a configuration of rectilinear motion in which the ~~steered~~^{STEERING} wheels 1' and 1'' are positioned parallel to the middle plane B.

In order to pass from the configuration of rectilinear motion shown in the Figures 3 and 5A to the configuration of maximal steering shown in the Figures 4 and 5E, the sector gears 15 are rotated in the direction indicated by the arrows R and, consequently, the ~~steered~~^{STEERING} wheels 1' and 1'' are rotated in the direction of the arrows S.

In Figure 6 a version of the steering apparatus 3 is shown in which the pinion 10 engages with a sector gear 15, which is driven to rotate around the pivot 12 by means of link means. Such link means comprises a connecting rod 16 having one end pivotally connected with the sector gear 15 by means of a

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further pivot 17 and a further end, opposite said one end, pivotally connected with stem means 19 of a cylinder 18, for example a hydraulic cylinder, anchored to the frame 8. The pivot 12 is held in a fixed position with respect to the frame 8 by means of a plate 20 fixed to the sleeve 7.

The ^{STEERING} ~~steered~~ wheels 1' and 1'' are provided with respective steering apparatuses 3' and 3'', operating in an independent manner, each being controlled by the respective cylinder 18.

Figures 7 and 8 show other versions of the steering apparatus 3, which controls at the same time both ^{THE STEERING} ~~steered~~ wheels 1' and 1''.

The steering apparatus 3 is in fact provided with link means that connects sector gears 15' and 15'', that engage with respective pinions 10' and 10'' each of which mounted on a respective stem 4' and 4''.

In the version of Figure 7, each sector gear 15' and 15'' is pivotally connected with a respective connecting rod 16' and 16''.

The connecting rod 16' is pivotally connected with one end of connecting rod means 19 of a double-acting cylinder 21, whereas the connecting rod 16'' is pivotally connected with a further end of the connecting rod means 19, opposite said one end, such one and further ends extending at opposite sides of the double-acting cylinder 21.

The cylinder 21 is anchored to the frame 8 in a symmetrical position with respect to the central plane B of the lift truck 2.

As shown in EP 0741069, the double-acting cylinder 21 can oscillate with respect to the frame 8, so as to follow the translation of the stems 4' and 4'', along the direction of the axis Z.